

# Off-Road Mobile Sources

## Emissions Inventory Update

September 11, 2006

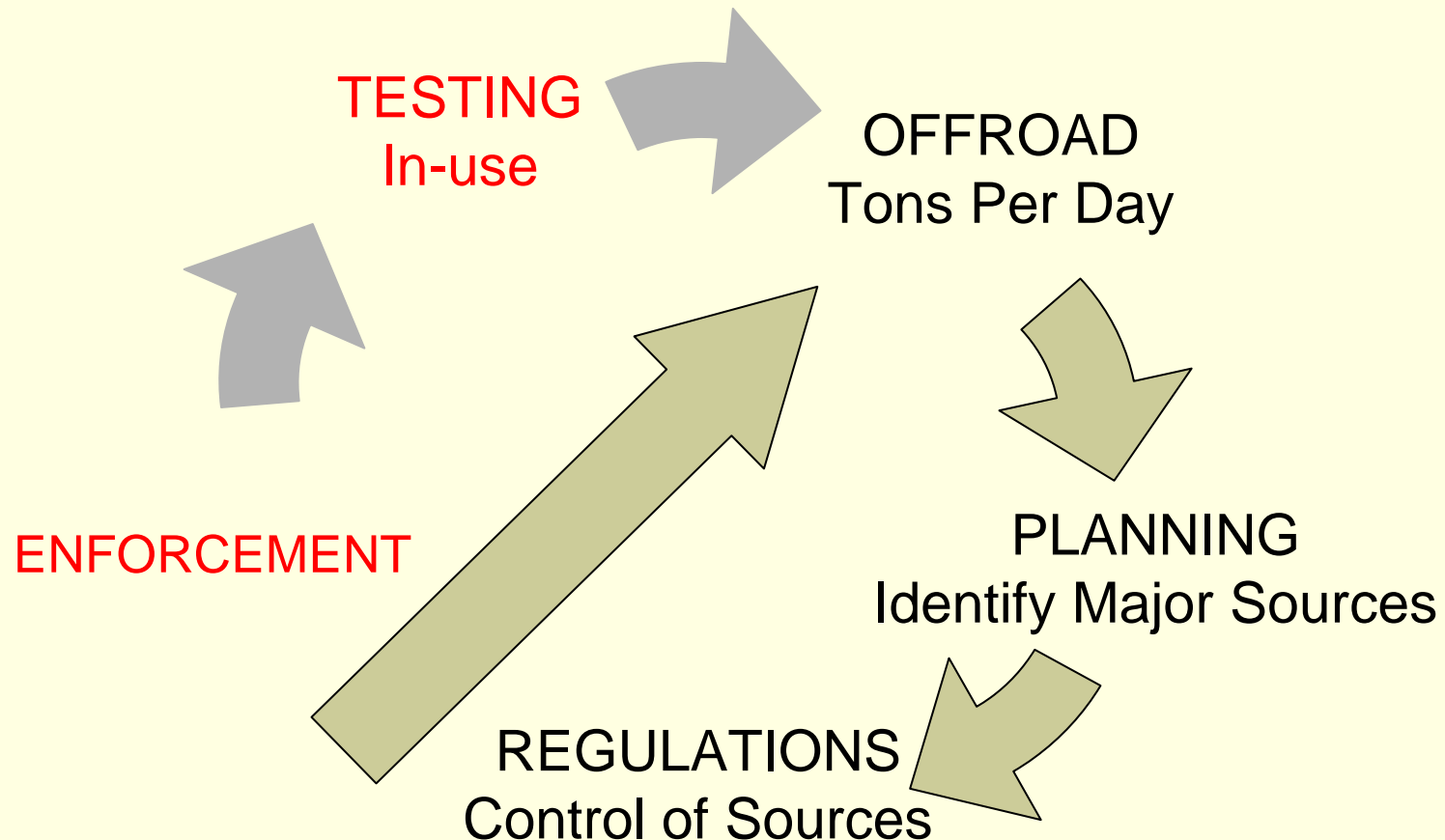
# Outline

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- OFFROAD Model Equipment
  - Population and Activity
  - Emission Factors
- Locomotives
- Cargo Handling Equipment
- Gas Cans
- Ocean-Going Vessels
- Commercial Harborcraft

# OFFROAD MODEL EQUIPMENT CATEGORIES

How's it updated?



## **OFFROAD Model**

- Recreational Vehicle
- Construction and Mining
- Industrial
- Lawn and Garden
- Agricultural
- Commercial
- Logging
- Airport Ground Support
- Oil Drilling
- Military Tactical
- Dredging
- Other Portable
- Entertainment
- Railyard Operations
- Pleasure Craft
- Transport Refrigeration

## **Modules outside of OFFROAD Model**

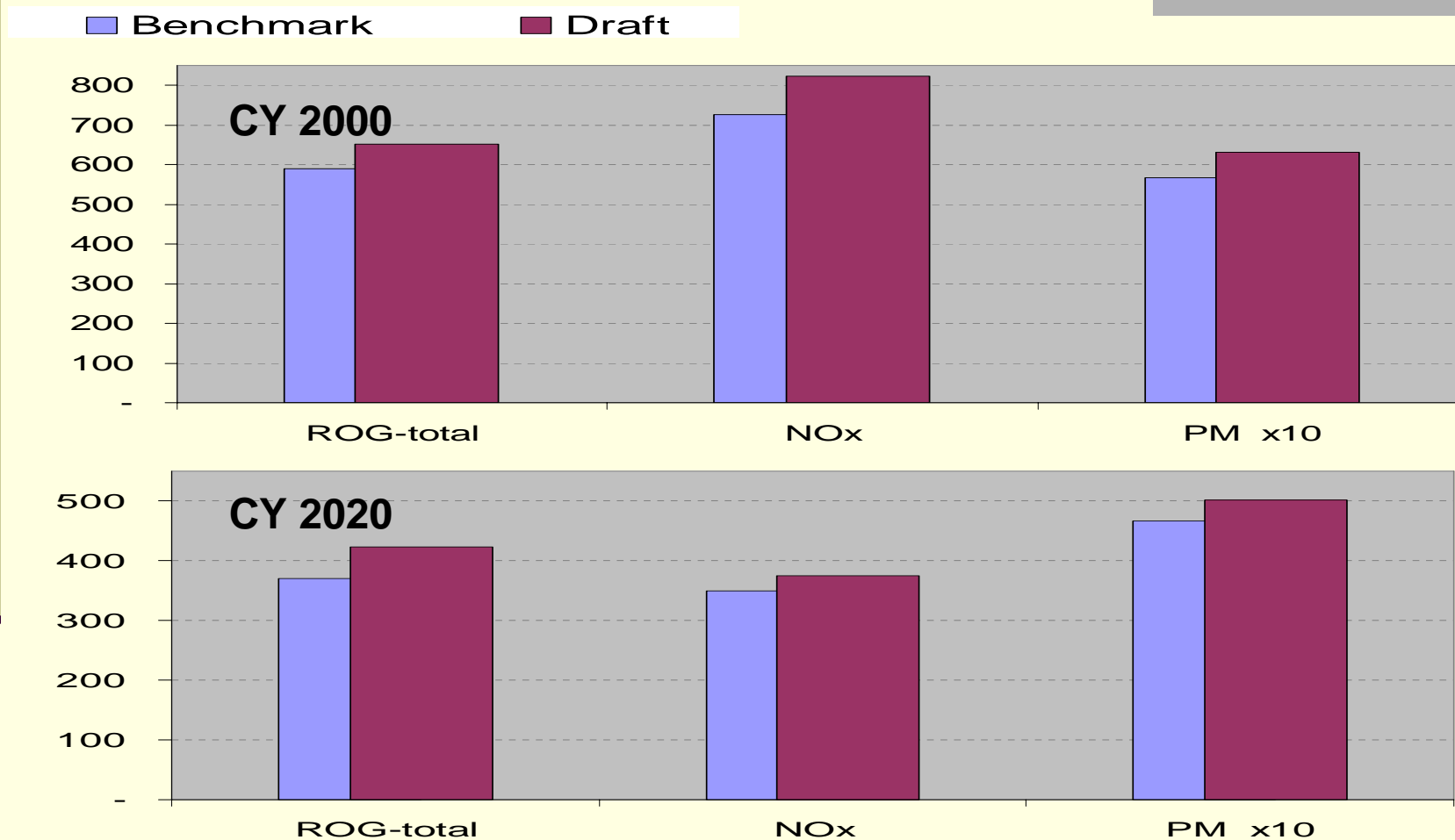
- Cargo Handling Equipment
- Locomotives
- Gas Can
- Ocean-going Vessels
- Harbor Craft

# OFFROAD Updates

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- Almanac 2003 – Benchmark as EMFAC 2002
- 2007 SIP Planning Inventory (Draft)

# Summer Statewide Emissions (tpd)



# Reactive Organic Gas (ROG) Emissions Comparison to Benchmark

Category	2000			2020		
	Benchmark	Draft	Delta	Benchmark	Draft	Delta
Recreational Vehicles	52	57	4	63	91	28
Lawn and Garden	78	130	51	59	84	26
Construction and Mining	43	59	16	17	24	8
Industrial	17	22	5	5	7	2
Transport Refrigeration Units	6	13	8	2	4	2
Light Commercial	28	41	13	14	16	1
Airport Ground Support	1	3	1	0	1	1
Agricultural	27	35	8	9	10	1
Pleasure Craft	331	284	-47	198	182	-16

# NOx Emissions

## Comparison to Benchmark

Category	2000			2020		
	Benchmark	Draft	Delta	Benchmark	Draft	Delta
Transport Refrigeration Units	26	21	-4	12	29	16
Pleasure Craft	37	36	0	48	64	16
Lawn and Garden	7	15	8	8	13	6
Industrial	68	94	26	23	28	5
Oil Drilling	12	26	14	5	7	2
Airport Ground Support	8	12	5	3	5	2
Light Commercial	43	68	25	28	29	1
Logging	11	11	0	4	2	-2
Construction and Mining	331	359	28	144	141	-3
Recreational Vehicles	4	2	-3	6	3	-3
Agricultural	178	174	-4	68	54	-14



# PM Emissions Comparison to Benchmark

	2000			2020		
Category	Benchmark	Draft	Delta	Benchmark	Draft	Delta
Pleasure Craft	13	13	1	24	31	7
Lawn and Garden	2	3	2	1	3	2
Light Commercial	3	5	2	3	3	0
Transport Refrigeration Units	3	3	0	1	0	-1
Agricultural	11	11	-1	5	3	-2
Construction and Mining	22	22	0	11	8	-3

# OFFROAD: Population and Activity

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- Base year population
- Annual activity
- Average horsepower
- Useful life
- Load factor
- Growth factor
- Survival Curve

## ■ Small Off-Road Equipment (SORE)

- Incorporated new activity estimates obtained from the Lawn and Garden Survey conducted under USEPA 103 grant.
- Modified small off-road engine survival rate curves using information from Outdoor Power Equipment Institute (OPEI).

## ■ Agricultural Equipment

- Agricultural Advisory Committee
- Incorporated new agricultural equipment growth rates for SJV.

## ■ Airport Ground Support Equipment (GSE)

- Updated gasoline powered GSE based on data provided during the GSE MOU process.
- Revised population, activity, average horsepower, useful life, and allocation factors.
- Gas 4-stroke – added passenger stand, sweeper, generator, catering truck and hydrant truck
- CNG – passenger stand, sweeper and catering truck

## ■ Recreational Marine

- Updated growth factors with more recent DMV data

# Recreational Vehicles

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- Updated population and growth factors for MC, ATV, and snowmobiles using DMV CY1990-2005 registration.
- Updated county allocation factors based on DMV CY2005 data
  - No other county-level data was received; growth factor is statewide.
  - Appropriate for evaporative emissions but not exhaust.
- No fuel/hp splits so the distribution patterns remain the same.
- Used NONROAD 2005 activity for specialty vehicle carts.
- Reflected 1997 and newer purchases of golf carts operating in non-attainment areas mandated as electric.

# Diesel Equipment

## ■ Portable Equipment Registration Program

- Construction and Mining
- Lawn and garden
- Light-commercial
- Oil drilling
- Military Tactical
- Dredging
- Entertainment
- Railyard Operations

## ■ Transportation Refrigeration Units

- Based on data gathered during the ATCM development
- Updated population, activity, average horsepower and useful life.

# Diesel Equipment

- Diesel In-use Regulatory Development
  - McKay and Diesel In-use Survey
  - Construction
    - Longer Useful Life
      - Base year MY distribution
      - Survival curve
    - Activity by Age
    - Growth factor
  - Industrial
  - Airport Ground Support Equipment
  - Oil Drilling

# Gasoline Equipment

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- Pleasure Craft
  - Correct and update growth factor
  - Update base year population
- Snowmobiles
  - USEPA load factor and activity



# Allocation Factor

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## Issue: Area of Registration vs. Area Use

- Recreational Vehicles
  - Based on area registration from DMV
  - Appropriate for evaporative
  - Inappropriate for exhaust
- Pleasure Craft
  - Based on fuel consumed from survey
  - Appropriate for exhaust
  - Inappropriate for evaporative

# Emission Factors

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- Exhaust
  - Zero hour
  - Deterioration
- Evaporative
- Adjustment Factors
  - Temperature and Relative Humidity
  - HC Conversion Factors
- Fuel Correction Factors

# Emission Factors: Adopted Standards

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- More stringent exhaust and evaporative standards for SORE
- USEPA Tier 4 standards for all diesel engines
- New USEPA standard for preempted large spark-ignited (LSI) engine
- Recreational Vehicles
  - Verified off-road motorcycles (OFMC) G4 MY1998+ controlled engines are based on certification data for HC and CO.
  - Updated emission factors for golf carts & specialty vehicles; subject to SORE and LSI controls.
  - Applied 2005 NONROAD emission factors for snowmobiles.

# Evaporative Emissions

- Incorporated new evaporative emission rates for SORE from the ATL study.
- Estimated evaporative emissions for non-SORE gasoline powered engines (all horsepower categories) using the ATL study results.
- Recreational Vehicles
  - Added OFMC and ATV evaporative emission factors as g/mi. All other recreational equipment use g/hr.
  - For snowmobiles, the uncontrolled rates are the same as for ATV while federal controls begin in 2008.
  - For golf carts and specialty vehicles, small off-road equipment <25hp is used.

# Adjustment Factors

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- Updated temperature and relative humidity data to reflect Federal 8-hr Summer Planning conditions.
- Updated HC conversion factors to correlate Total Organic Gas (TOG), Reactive Organic Gas (ROG), and CH<sub>4</sub> by fuel type for exhaust and evaporative emissions.
- Reflected input emission factors as THC.

# Fuel Correction Factors

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## ■ Gasoline

- Revised assumed benefit of reformulated gasoline to be consistent with EMFAC.
- Reflected implementation of Phase 3 Gasoline.
- Incorporated ethanol impact for gasoline.

## ■ Diesel

- Revised assumed benefit of clean diesel similar to on-road vehicles.

# Locomotives

Lead Staff:  
Walter Wong

# Locomotive Inventory Update

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- Update Class I railroad inventory to reflect growth from goods movement at the ports
- Reflect SC 1998 MOU/State 2005 MOU



# Class I Updates

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- Updated class I railroad inventory
  - Class I (revenue >\$261.9 million or more) are major railroad companies such as Union Pacific and BNSF
  - Growth factors revised
    - Reflect ocean-going vessel (OGV) growth
  - Revise fuel efficiency

# Growth Rates for Class I

- Type of operations
  - Intermodal
  - Mixed/Bulk
- Intermodal growth rate has two component
  - International originated
  - Domestic originated
- New composite intermodal growth rate
  - International intermodal grows with ocean-going vessel growth.
  - Domestic intermodal grows with changes in domestic traffic level (based on American Association of Railroads (AAR) statistics).
- Mixed/Bulk growth rate is based on domestic traffic level

# Fuel Efficiency

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- Improved assessment of fuel efficiency gains 1987-2000.
  - Based on reanalysis of national AAR data 1975-2003
  - Fuel efficiency gain of about 2% per year.

# Locomotive MOU

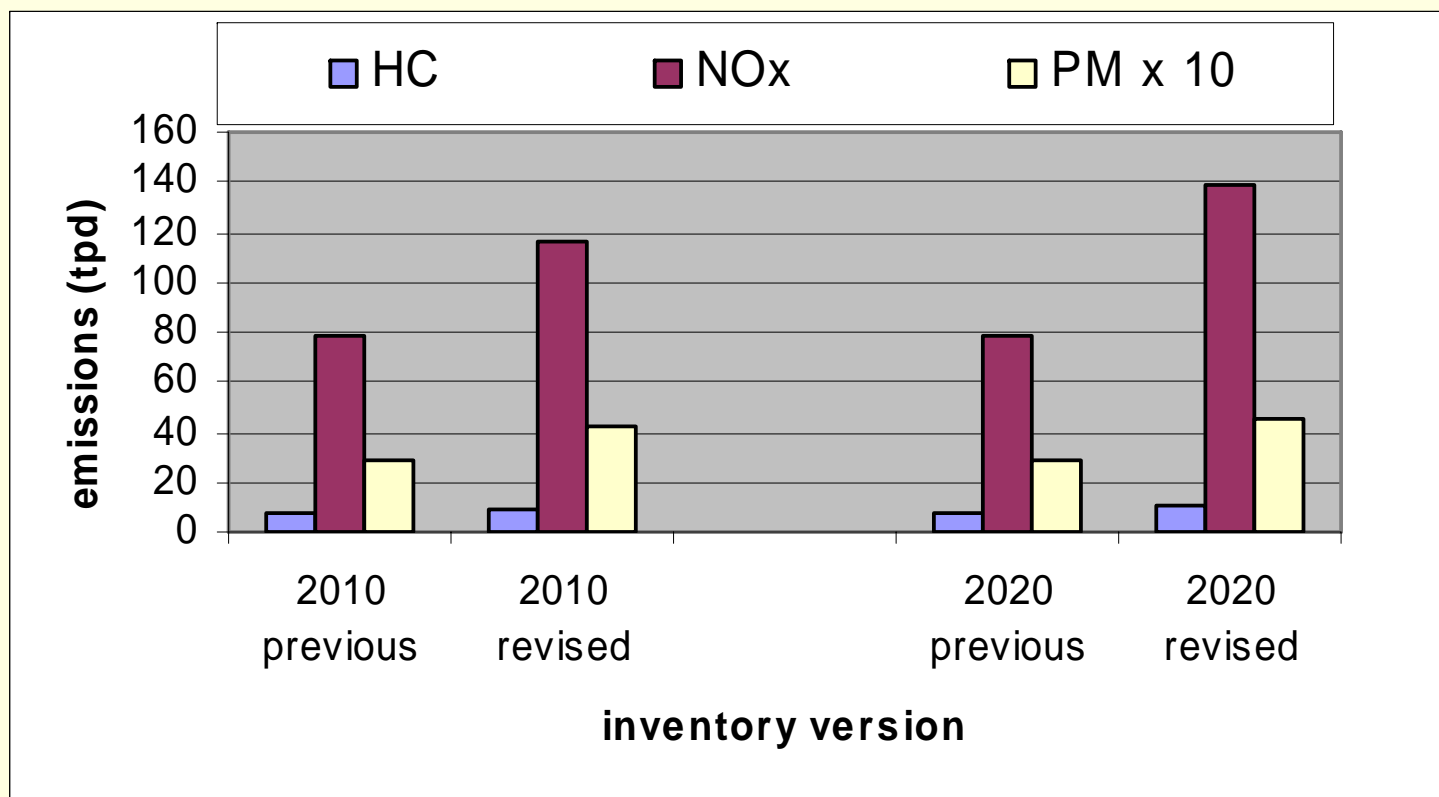
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- SC 1998 MOU
  - For CYs 2010+ NO<sub>x</sub> lower in SCAB than rest of the state
  - Reflect MOU benefit effect for other air basins
  
- State 2005 MOU
  - Reduce idling by 20% at rail yards
  - Maximize use of ultra low sulfur fuel by 2007

# Revised 2010 Statewide Locomotive Emissions (tpd)

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	4.59	18.05	49.87	2.02	0.47
Local/Short-Run	0.78	3.03	11.51	0.30	0.01
Mixed/Bulk	3.49	13.68	40.78	1.60	0.35
Passenger/Amtrak	0.49	1.00	7.61	0.21	0.01
Yard/Switcher	0.45	1.21	6.57	0.16	0.01
<b>Total</b>	<b>9.80</b>	<b>36.97</b>	<b>116.34</b>	<b>4.29</b>	<b>0.85</b>

# Impact of Changes on Statewide Locomotive Emissions Inventory (tpd)



# Cargo Handling Equipment (CHE)

Lead Staff:  
Debbie Futaba

# Cargo Handling Equipment (CHE)

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- Forklifts
- Yard Tractors
- Sweepers/Scrubbers
- Cranes
- Excavators
- Material Handling Equipment
- Tractor/Loader/Backhoe
- Other General Industrial Equipment



# Cargo Handling Equipment (CHE)

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- This category is comprised of CHE equipment located at ports and railyards throughout California.
- Currently, the inventory is an external module, but will be incorporated into the OFFROAD Model.
- Inventory based on 2001 POLA/POLB data and 2004 equipment survey (SSD) for ports and railyards.
- The regulatory emissions inventory was adopted by ARB in December 2005:

<http://www.arb.ca.gov/msprog/offroad/cargo/cargo.htm>

# Cargo Handling Equipment (CHE)

Statewide population for CHE at the Ports:

Port

<u>Equipment</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
Crane	281	359	403	468
Excavator	28	29	31	32
Forklift	451	503	534	567
Material Handling Equip	494	697	842	1018
Other General Industrial Equip	39	54	66	79
Sweeper/Scrubber	29	41	49	60
Tractor/Loader/Backhoe	92	130	162	196
Yard Tractor	2051	2393	2650	2934
<b>Port Total:</b>	<b>3464</b>	<b>4206</b>	<b>4738</b>	<b>5355</b>

# Cargo Handling Equipment (CHE)

## Statewide population for CHE at the Railyards:

### Rail

<u>Equipment</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
Crane	77	103	117	134
Forklift	24	27	33	40
Material Handling Equip	28	41	62	93
Other General Industrial Equip	4	6	9	14
Sweeper/Scrubber	1	2	2	4
Tractor/Loader/Backhoe	1	2	2	4
Yard Tractor	306	417	597	856
<b>Rail Total:</b>	<b>442</b>	<b>597</b>	<b>823</b>	<b>1145</b>

# Cargo Handling Equipment (CHE)

**Activity (hr/yr) for CHE at the Port and Railyards includes activity growth through 2020:**

<u>Equipment</u>	Port				RailYard			
	Up to 2010	Post 2010	% Increase	% Increase	Up to 2010	Post 2010	% Increase	% Increase
	Base Activity	Base Activity	2004-2010	2011-2020	Base Activity	Base Activity	2004-2010	2011-2020
Crane	1371	1673	0.029	0.023	1632	2057	0.034	0.022
Excavator	2222	2333	0.007	0.018	-	-	-	-
Forklift	1098	1274	0.021	0.018	803	923	0.020	0.032
Material Handling Equip	2388	2818	0.024	0.018	2388	2914	0.029	0.060
Other Gen Industrial Equip	693	693	0.000	0.000	1632	1632	0.000	0.000
Sweeper/Scrubber	872	872	0.000	0.000	872	872	0.000	0.000
Tractor/Loader/Backhoe	755	823	0.012	0.018	755	755	0.000	0.000
Yard Tractor	2536	3043	0.026	0.022	1289	1767	0.046	0.056

# Cargo Handling Equipment (CHE)

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## Deterioration Methodology:

The deterioration methodology sets a maximum % increase over the equipment's life:

$$\begin{aligned} \text{drEF} &= Z_h * (\text{dr} * \text{CummHrs} / \text{TotalHrs} + 1) \\ &= [Z_h * \text{dr} / \text{TotalHrs} * \text{CummHrs}] + Z_h \\ &= Z_h + [Z_h * \text{dr} / \text{TotalHrs}] * \text{CummHrs} \end{aligned}$$

where: dr = deterioration rate that is the max % increase based on  
on-road LHDT, MHDT and HHDT

# Cargo Handling Equipment Emissions

## Statewide NOX and PM Emissions in tpd for CHE at the Ports:

Port	Equipment	NOX				PM			
		2005	2010	2015	2020	2005	2010	2015	2020
	Crane	1.58	1.48	1.39	1.18	0.06	0.03	0.02	0.02
	Excavator	0.22	0.18	0.04	0.04	0.01	0.00	0.00	0.00
	Forklift	0.40	0.37	0.30	0.16	0.02	0.01	0.01	0.00
	Material Handling Equip	3.14	3.17	2.08	1.51	0.10	0.08	0.05	0.04
	Other General Industrial Equip	0.06	0.06	0.02	0.02	0.00	0.00	0.00	0.00
	Sweeper/Scrubber	0.04	0.04	0.02	0.02	0.00	0.00	0.00	0.00
	Tractor/Loader/Backhoe	0.16	0.17	0.07	0.07	0.01	0.01	0.00	0.00
	Yard Tractor	11.00	6.02	1.65	0.98	0.32	0.14	0.03	0.04
	<b>Port Total:</b>	<b>16.60</b>	<b>11.48</b>	<b>5.58</b>	<b>3.98</b>	<b>0.51</b>	<b>0.28</b>	<b>0.11</b>	<b>0.10</b>

# Cargo Handling Equipment Emissions

## Statewide NOX and PM Emissions in tpd for CHE at the Rail Yards:

Rail	NOX				PM			
	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>	<u>2005</u>	<u>2010</u>	<u>2015</u>	<u>2020</u>
<b><u>Equipment</u></b>								
Crane	0.2951	0.2729	0.2278	0.1479	0.0091	0.0053	0.0035	0.0024
Forklift	0.0199	0.0166	0.0143	0.0092	0.0008	0.0005	0.0003	0.0002
Material Handling Equip	0.2000	0.1586	0.1014	0.1161	0.0080	0.0041	0.0025	0.0033
Other General Industrial Equip	0.0167	0.0184	0.0076	0.0079	0.0004	0.0005	0.0002	0.0002
Sweeper/Scrubber	0.0021	0.0024	0.0009	0.0009	0.0001	0.0001	0.0000	0.0000
Tractor/Loader/Backhoe	0.0006	0.0007	0.0005	0.0006	0.0000	0.0000	0.0000	0.0000
Yard Tractor	0.6445	0.4784	0.1216	0.1454	0.0172	0.0118	0.0037	0.0070
<b>Rail Total:</b>	<b>1.18</b>	<b>0.95</b>	<b>0.47</b>	<b>0.43</b>	<b>0.04</b>	<b>0.02</b>	<b>0.01</b>	<b>0.01</b>

# Portable Fuel Containers (Gas Cans)

Lead Staff:  
Daisy Wong



# Gas Can 2006 Updates

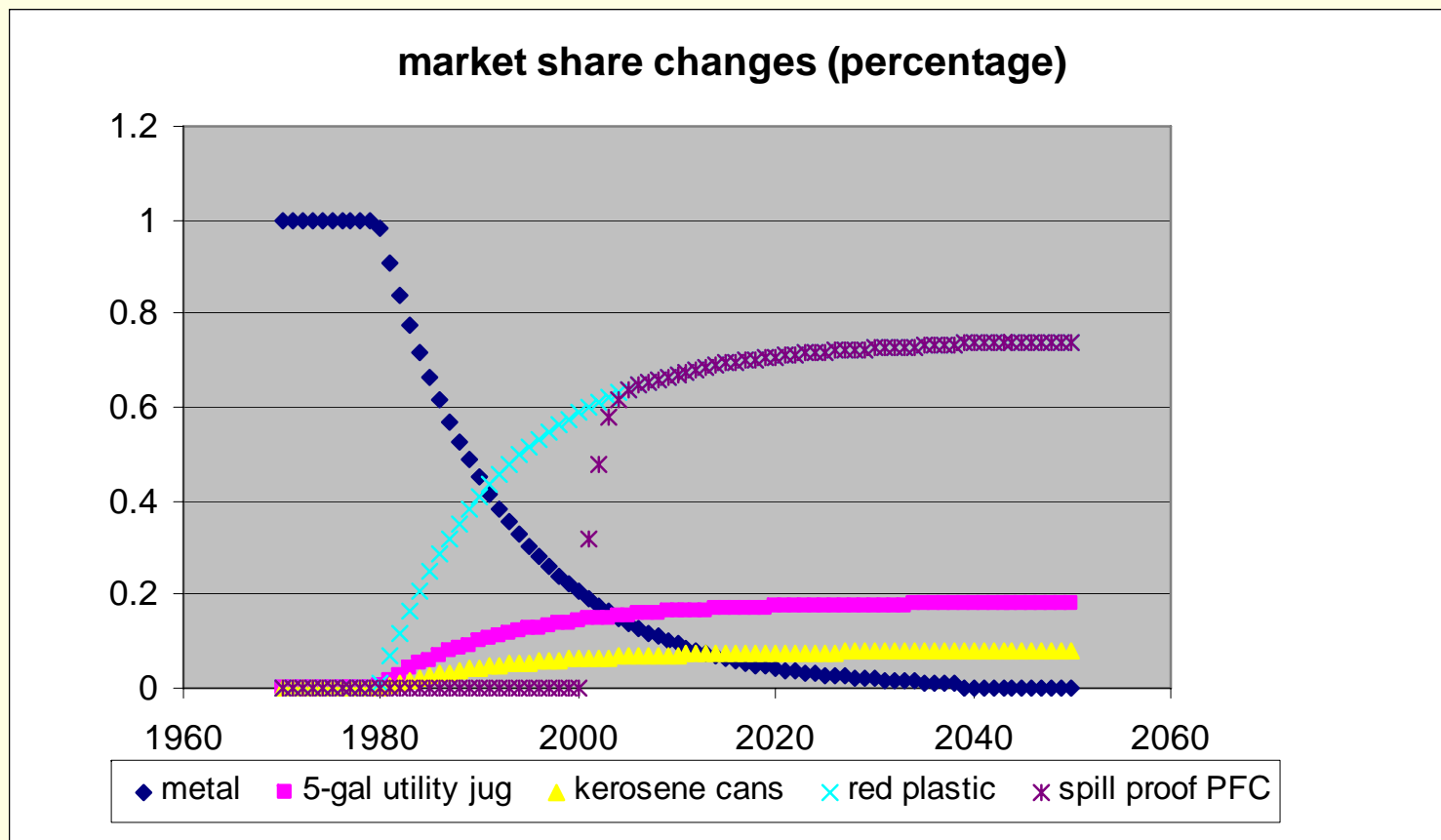
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- To be reflected in the Planning Emission Inventory
- Gas Can Types
- Residential gas can populations
- Reflect changes in the 2005 PFC regulation
- Reflect fuel changes from RFG2 to RFG3

# Gas Can 2006 Updates

1999 PFC Regulatory Emission Inventory	2006 PFC Emission Inventory Updates
Metal Can and Plastic Can.	Metal Can Plastic Can is sub-divided to 5-Gal jug, kerosene (blue plastic) cans, red plastic cans and spill-proof PFCs.
Percentage of Metal vs. Plastic Can remain constant through out the years.	Metal cans are slowly replaced by plastic cans; conventional gas cans are slowly replaced by spill proof PFCs or cans that meet the regulation requirement.

# Gas Can 2006 Updates



# Residential PFC Population

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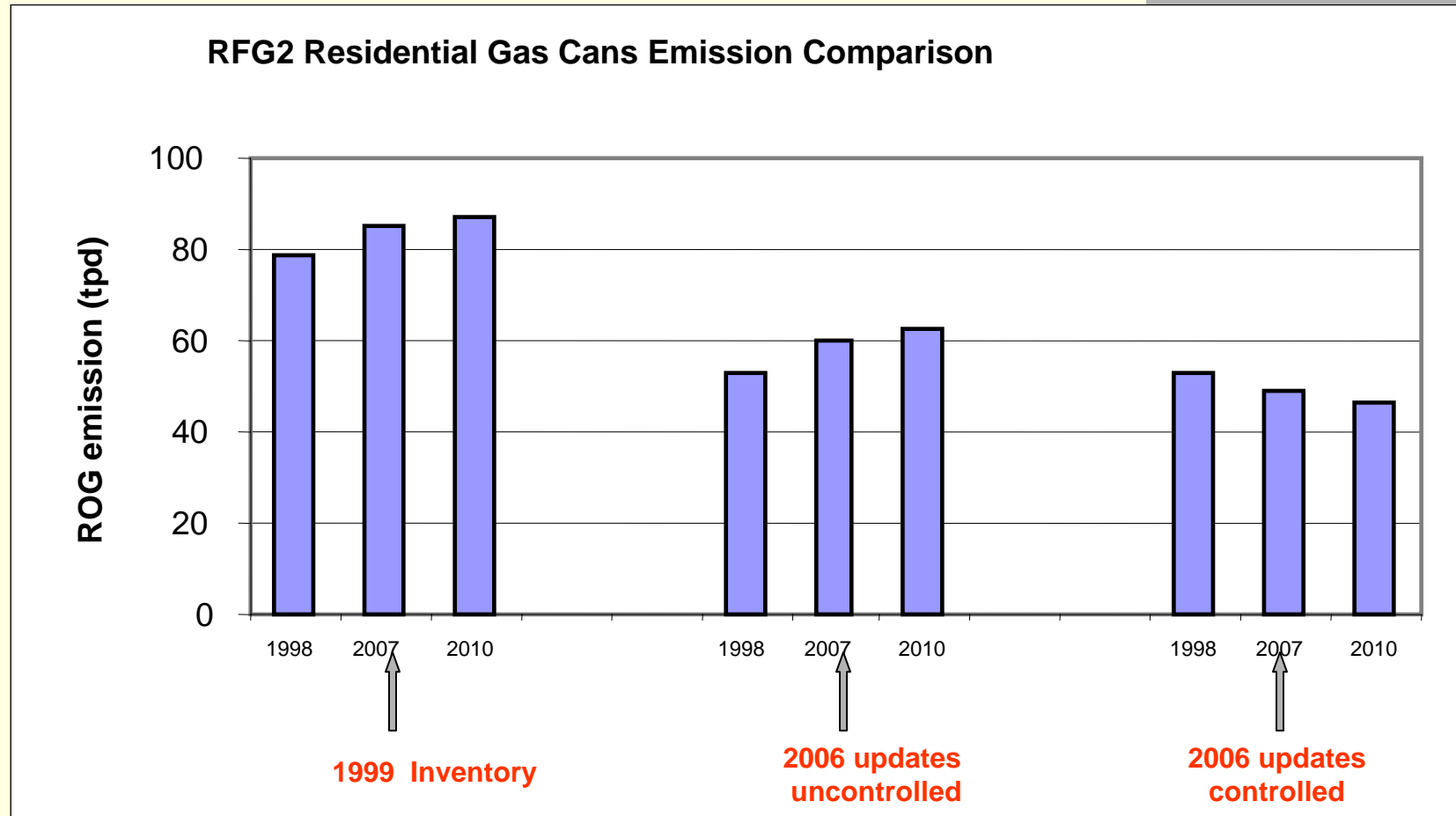
= Occupied Household Units

\* Percentage Household with Gas Cans

\* Average Number of Gas Cans per Household

	1999 PFC Regulatory Emission Inventory	2006 PFC Emission Inventory Updates
Occupied Household Units	based on 1990-1998 California Department of Finance data to project growth	1970-2005 California Department of Finance Census 2005 actual data.
Percentage Household with Gas Cans	<b>46%</b> 1998 survey, assumed constant through out the years	<b>32.8%</b> 2004 survey, declining trend will be taken account into new inventory
Average Number of Gas Cans per Household	<b>1.8 cans/household</b> 1998 survey, assumed constant through out the years	<b>1.66 cans/household</b> 2004 survey, declining trend will be taken account into new inventory

# Residential Gas Can Summary



# Adopted Regulations not Reflected in OFFROAD

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- TRU ATCM
- Portable Equipment ATCM
- Off-road Motorcycle Green/Red Sticker Program
- Carl Moyer Program

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